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A PLEISTOCENE MOLLUSCAN FAUNA FROM PHILLIPS COUNTY, KANSAS.

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Plate XVIII.

(Contribution from the Zoological Laboratory, No. 202.)

RECENTLY, in looking over some stored fossils, Mr. H. T. Martin, of the University of Kansas Museum, found along with some vertebrates a small series of fossil shells from Long Island, Kan. The vertebrates were collected by E. P. West, and it is probable that the shells were also collected by him, although there was no name on the label. An opportunity to study this material was given the writers by Prof. C. E. McClung, to whom we are duly thankful. In regard to the topography and history of the region Mr. Martin was able to give much interesting information.

A hurried examination of this material showed that it belonged to a fauna essentially different from that which lives at the present time not far distant from Long Island, in localities where collecting has been done. Most of the Long Island species were not represented in our collections from points nearer than northern United States.

In order to obtain a more complete series of the shells and data in regard to the horizon in which they occur, a trip was made to the region in October, 1910. We started at Norton, twenty-five miles southwest of Long Island, and descended Prairie Dog creek to that point. Recent shells were collected along the route and fossils at many railroad cuts and exposures along the creek. The white Miocene rocks capping the hills

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were also examined for shells. At Long Island, along the creek bank, is an especially good exposure of Pleistocene. The Miocene of the locality is famous for its vertebrates.

As three faunas are represented in the one locality, it is well to consider them separately.

RECENT MOLLUSKS OF THE REGION.

The living mollusks of the locality belong to that fauna designated by the U. S. Biological Survey* as Upper Sonoran. As to shells, this fauna is characterized not so much by the development of peculiar species or subspecies as by the absence of a very large proportion of species belonging to the Carolinian zone to the eastward. West of the Mississippi river these species gradually fade out, some species and groups not extending as far as others. If the westward limit of the most characteristic of Carolinian shells, the large toothless *Polygyras*, be used for the boundary between the Carolinian and Upper Sonoran zones, we find the Carolinian extending only as far west as the vicinity of Topeka, Kan. This is somewhat to the eastward of the boundary as plotted on the faunal map.

Phillips county, lying far west of this, is wholly beyond the influence of the Carolinian zone, and its fauna is typically Upper Sonoran. This zone and fauna extends northward almost to the northern boundary of the United States, beyond which lies the transition realm; between these two there is little intermingling, the latter being characterized by a large number of specialized species.

Mollusks are not abundant in the Upper Sonoran, and belong chiefly to the groups of small species; the *Succineas* are the largest of the region. Each group, as a rule, has a different habitat, but a favorable locality for many species is along the base of the crumbling Miocene ledges at the tops of the hills. Trees and shade are confined to the very banks of the creeks, but many shells can be found on the bare prairies about the bases of grasses, brush and cactus, where this is present.

The streams are almost destitute of shells. This is doubtless due to their sandy character and the fact that they go dry in some seasons. Occasional deep holes in Prairie Dog creek are, however, favorable for bivalves, and four species were collected.

* U. S. Biological Survey, Fourth Provisional Zone Map of North America; Merriam, Bailey, Nelson, Preble, 1910.

LIST OF RECENT SPECIES.

<i>Sphaerium</i> sp?	<i>Vallonia gracilicostata</i> Reinhardt.
<i>Lampsilis parva</i> Lea.	<i>Vallonia parvula?</i> Sterki.
<i>Quadrula lachrymosa</i> Barnes.	<i>Pupoides marginatus</i> Say.
<i>Anodonta</i> sp?	<i>Bifidaria procera cristata</i> P. & V.
<i>Physa anatina</i> Lea.	<i>Bifidaria armifera</i> Say.
<i>Planorbis bicarinatus</i> Say.	<i>Bifidaria holzingeri?</i> Sterki.
<i>Zonitoides miniscula</i> Binney.	<i>Bifidaria tappaniana</i> C. B. Adams.
<i>Zonitoides singleyana</i> Pilsbry.	<i>Succinea grosvenori</i> Lea.

MIOCENE OF THE REGION.

On Prairie Dog creek, between Norton and Long Island, there are many fine exposures of what is generally known as Loop Fork. According to Matthew* this belongs in the upper Miocene series, and the short-legged rhinoceroses are the most abundant fossils.

The upper layer of this formation is the most conspicuous, as a hard layer of porous white limestone caps most of the hills along the route. This layer weathers poorly, and in the majority of places exposes a perpendicular section on the hillside. Beneath this there are many layers of sand and other rocks, which are well exposed in a deep ravine south of Long Island about five miles. At Almena a beautiful yellow sand is exposed in great quantities. The layer is about forty feet thick, and two mastodon skeletons are exposed.

All of the strata are fossil-bearing, rhinoceroses being found most abundantly, but many other groups are common. *Euphorbia* seeds were found in all the layers examined.

The formation is doubtless of Miocene lake origin, and may contain fossil land shells in some places, but none were found by us. These are occasionally found in the John Day region in Oregon and the White river Miocene of Colorado, from which it may be inferred that they exist sparingly in the Loop Fork. Those land shells found in the former two divisions of the Miocene belong to a warmth-loving fauna, and as they are not greatly different in general character from species inhabiting the Carolinian zone at the present time, it may be supposed that the climate of the Miocene period was not essentially different from that of the region at the present time.

In later times there has been a gradual increase in cold,

* W. D. Matthew, Bull. Am. Mus. Nat. Hist. XII, p. 65.

which reached its climax in the southern extension of the glaciers to northern Kansas, and still later, of course, the former conditions have returned.

PLEISTOCENE OF THE REGION.

To the Pleistocene we refer a large number of shell-bearing deposits found all the way along Prairie Dog creek between Norton and the Republican river. Some of the deposits are of uniform consistency throughout and seem to be of aerial origin, while others are distinctly laminated and contain some gravel and nodules of white disintegrated Miocene rock, indicating that they are of fresh-water origin.

One mile east of Long Island the bed of the creek is formed of a comparatively tough green marl, which contains an abundance of fossil shells. The creek has cut down through this marl, which is not all of the same consistency, for a distance of thirty feet. Shells are scattered all through this, except in the upper ten feet. The marl seems unmistakably of fresh-water origin, and most of the fresh-water species were found in it.

West of Long Island about three miles there is an exposure of about twenty feet of sand lying on top of Miocene shales, which form the bed of the creek. The deposit contains an abundance of shells, but owing to the few *Lymnaeas* found, and structure of the whole, it is supposed to be of wind origin. This deposit was the only one seen which had the columnar structure of the Mississippi and Missouri river valleys. Along the latter streams the loess exists as a chain of hills along the banks of the streams, but if such a condition ever existed along Prairie Dog creek, erosion has eliminated all traces of it. The deposit under consideration could have been drifted by the wind, owing to the position of the surrounding Miocene hills.

The species found in the deposits, which seem to be of wind formation, are, with the exception of most of the fresh-water ones, the same as those found in the marl east of Long Island. The latter is of undoubted water origin, and all seem to be of contemporaneous deposition.

In the loess of the Mississippi and Missouri river banks there are an abundance of fossils belonging to species, with one or two exceptions, exactly the same as inhabit the region at the present time. They have lived in the locality ever

since the beginning of the formation of the beds, because they are found from the bottom up. But in the Prairie Dog creek beds there are found no less than twenty-six species which do not live to-day within several hundred miles of the formation. They are as follows:

<i>Psidium</i> sp?	<i>Vitrca hammonis.</i>
<i>Psidium</i> sp.	<i>Pyramidula cronkhitei cockerelli.</i>
<i>Sphaerium</i> sp.	<i>Punctum pygmæum.</i>
<i>Ancylus parallelus?</i>	<i>Sphyradium alticola.</i>
<i>Lymnæa parva.</i>	<i>Sphyradium hasta.</i>
<i>Lymnæa obrussa?</i>	<i>Pupilla muscorum.</i>
<i>Lymnæa humilis.</i>	<i>Bifidaria meclungi.</i>
<i>Lymnæa desidiiosa.</i>	<i>Vertigo modesta.</i>
<i>Planorbis trivolvis.</i>	<i>Vertigo gouldi.</i>
<i>Planorbis truncatus.</i>	<i>Vertigo martini.</i>
<i>Planorbis deflectus.</i>	<i>Succinea avara.</i>
<i>Zonitoides arborea.</i>	<i>Succinea sillimani.</i>
<i>Euconulus fulvus.</i>	<i>Carychium exile canadense.</i>

Great changes in climate must have taken place in order that this number of species should completely die out of the region. Many of these twenty-six species never could have lived on a barren, sandy, treeless plain. The entire surroundings must have been vastly different in regard to water and vegetation for the existence of such moisture-loving forms as *Vertigo*, *Carychium*, *Euconulus*, etc.

Of these twenty-six species fully 50 per cent are associated at the present time with a cold climate. They live in Canada and the northern parts of the United States and among the peaks of the Rockies. The natural conclusion to be drawn from this is that the Prairie Dog creek fauna lived during a cold epoch.

It may be stated that the fauna is as different from the loess fauna as from the recent fauna in the loess region.

It is generally admitted that the loess deposits are post-glacial. Their existence on the top of glacial drift indicates this, as also does the presence of a uniform fauna from bottom to top. If the deposits were formed during and after glacial time the bottoms would contain a different fauna from the top. The presence of the northern fauna in the Prairie Dog creek beds is good evidence that it is older than that of the loess, and that it lived during an invasion of cold from the north.

The Glacial Epoch, during which there may have been as many as five ice sheets in some localities, is the only descent

of cold known to have occurred in later geological times. The glaciers extended as far south as Lawrence, Kan., but there seems to be no evidence of the ice in Phillips county, which is in a somewhat more northern latitude. However, the existence of glaciers in or near the eastern part of the state would have a great effect upon the animals and plants of the western part of the state, because temperature conditions would be essentially the same. From this it seems that the Prairie Dog creek beds were deposited immediately preceding and during the Glacial Epoch. They will be placed provisionally in the upper Pleistocene.

The existence of this fauna so far southward is evidence that goes to prove the gradual beginning and long duration of the Glacial Epoch. Land snails are among the slowest of animals to be geographically distributed, and the time taken for this Canadian fauna to migrate several hundred miles to the southward must have been of considerable magnitude. It existed in the Long Island region during the deposition of at least thirty feet of sand, and died out when conditions changed and the glaciers disappeared. A few remnants of the fauna exist at the present time in eastern Kansas as *Pupilla muscorum* and *Euconulus fulvus*.

As most of the fauna is found in the Miocene of the locality, it seems that the descent of cold had not started at the close of that period.

There are some shells which we did not find in the deposits, but which would naturally be supposed to occur. On subsequent search a *Vitrina*, for instance, may be found. None of the Helicidæ were found as fossils. None of the family lives in the region at the present time, although *Polygyra fraterna* lives in Jewell county to the eastward.

ANNOTATED LIST OF PLEISTOCENE SPECIES.

1. *Psidium* (sp?)
2. *Psidium* (sp?)
3. *Sphærium* (sp?)

Three species of small bivalves were found. The first two are rare and the latter most common.

4. *Ancylus parallelus*? Say.

A single specimen found at Long Island probably belongs to this species.

5. *Lymnæa obrussa?* Say.

Several specimens were found which more nearly resemble this than any other species in our collections. The aperture, however, is shorter and broader.

6. *Lymnæa parva* Lea.

Fifteen specimens from the Long Island marl.

7. *Lymnæa desidiosa* Say.8. *Lymnæa humilis* Say.

The latter two species were quite common in the marl beds.

9. *Physa anatina* Lea.

This is a smooth *Physa*, agreeing with specimens of *anatina* from eastern Kansas identified by Mr. Bryant Walker.

10. *Planorbis trivolvis* Say.

This widely distributed species does not live in Prairie Dog creek at the present time. Several fossils were found.

11. *Planorbis truncatus* Say.

One specimen found at Long Island.

12. *Planorbis bicarinatus* Say.

Numerous specimens were found in the green marl near Long Island, and the species lives in Prairie Dog creek at the present time.

13. *Planorbis deflectus* Say.

Two specimens found.

14. *Zonitoides miniscula* Binney.

A few fossils found in a railroad cut just east of Norton.

15. *Zonitoides miniscula alachuana* Dall.

Fossils were found in two or three deposits. The shells are much smoother than recent specimens of either *alachuana* or typical *miniscula*.

16. *Zonitoides arborea* Say.

Several fossils found. The last whorl is rather more flattened than in recent specimens, and all trace of the brownish color was lost. In Kansas, this species does not live west of Topeka at the present time.

17. *Euconulus fulvis** Muller.

Quite common as a fossil, and typical. Fine spiral sculpture over the entire shell, and the whorls are almost six.

18. *Vitrea hammonis* Müller.

Several fossils were found in the different beds. The last whorl in-

* See Pilsbry and Ferris. Proc. Acad. Nat. Sci. Phila., 1910, p. 133.

creases rather more rapidly than in recent specimens. Lawrence is the farthest west the form lives in Kansas at the present time.

19. *Pyramidula cronkhitei cockerelli* Pilsbry.

One of the most abundant fossils. It can be collected by thousands. It lives at the present time no closer than the mountains of central Colorado.

20. *Helicodiscus parallelus* Say.

Common in all the beds.

21. *Punctum pygmæum* Draparnaud.

Rare; only a few specimens could be found, but owing to its small size it may have been overlooked.

22. *Vallonia gracilicostata* Reinhardt.

An abundant fossil in all the deposits examined.

23. *Vallonia parvula* Sterki.

Five specimens were found in a deposit of loam, near the surface, four miles east of Norton. This probably does not extend down into the Pleistocene formation, and it is doubtful if it lives in the region at the present time.

24. *Cochlicopa lubrica* Müller.

A common shell in the Pleistocene beds. In Kansas this shell is rare and does not live in the region at the present time. Hutchinson is apparently the western limit.

25. *Sphyradium alticola* Ingersoll.

This form is specifically distinct from *Sphyradium edentula*. The shell is much longer and the basal whorl is always expanded beyond the others. The whorls in *edentula* are five to six, while in *alticola* there are seven to eight.

Measurements of S. alticola.

Alt.	Diam.
3.33	1.74
2.81	1.11
2.70	1.14

The species is very common in the formation, and is said to live in the mountains of Colorado at the present time.

26. *Sphyradium hasta* Hanna & Johnston. Pl., fig. 5.

This form is rare in the deposits. The type is from the green marl formation and is deposited in the U. S. National Museum.

27. *Pupilla muscorum* Linnæus.

This is the most abundant fossil of the series. A very large number were collected, in which considerable variation is found. The edentulous form is the variety which occurs in greatest numbers, with those that have a single nodule-like tooth on the parietal wall not far behind. Two

forms of a bidentate *muscorum*; one, the most common of the two, has one tooth on the parietal wall and one on the columella; in the other the columella tooth is absent and is replaced by one on the palatal wall. The latter form is what is known as *bigranata*, but only a few specimens were found, while the former is quite common. All four of these forms intergrade to a remarkable degree, and the fact that all are found in the one locality makes the recognition of subspecies not feasible.

28. *Pupilla blandi* Morse.

This form has three teeth, and the shell is smaller and more cylindrical than *P. muscorum*. A few fossils were found. The species now lives in the mountains of Colorado.

29. *Bifidaria mcclungi* new species. Pl., figs. 1, 2.

Shell light brownish-yellow; composed of five to five and a half whorls. Lines of growth faint and apex smooth. Whorls well rounded and suture very deep. Umbilicus barely perforate. Peristome very broadly reflected and greatly thickened by white callous on the inner margin and the face; ends connected across the body whorl by a heavy callous. Teeth six. One parietal, large; heavy, and strongly bifid. The angular or outer portion from the columella is connected to the peristome by its upper extremity. It descends in a gentle curve and meets the parietal portion near the upper extremity of the latter. Both portions of the tooth are often divided transversely, as shown in figure 2. One columellar, large and heavy, and with a small, pointed subcolumellar. This is sometimes partly united to the upper tooth, in which case it is bifid, as shown in figure 1. One basal, small and conical. Lower palatal high and lamellar, set oblique to the aperture, and more deeply seated than the other teeth. Upper palatal small and conical. Immediately above the upper palatal tooth there is a nodule-like thickening of the margin of the lip. A low callous ridge on the outside of the shell just back of the reflected lip.

Measurements.

Alt.	Diam.
2.03	.96
2.07	1.00
2.44	1.00

Types in the U. S. National Museum from the Pleistocene of Phillips county, Kansas.

This species differs from any other of the *procera* group of *Bifidaria* in having the compound tooth on the columella. The very greatly thickened and expanded lip is also characteristic.

30. *Bifidaria holzingeri* Sterki.

Three specimens were found associated with *Vallonia parvula* in loam two feet below the surface. It probably does not extend down into the Pleistocene deposits, and it is doubtful if it lives in the region at the present time.

31. *Bifidaria armifera* Say.

Typical *armifera* is found as a fossil, and lives abundantly in the region at the present time.

32. *Vertigo modesta* Say.

Very common in all of the deposits. It is not found living in the state. The second parietal tooth is never developed in these specimens, and the shells are smaller and more cylindrical than the typical *modesta*.

Measurements.

Alt.	Diam.
2.02	1.07
1.97	1.00
1.80	1.16

33. *Vertigo gouldi* Binney.

Very common in the deposits. The columellar tooth is much heavier and the lower palatal more deeply seated than in the typical form, but we do not hesitate to refer the shells to this species.

34. *Vertigo martini* new species. Pl., fig. 3.

Shell light brown; ovate in outline. Lines of growth faint and oblique. Whorls, four and a half, well rounded, and the sutures well impressed. Apex smooth and white and obtusely pointed. Peristome thin and sharp, slightly expanded, and the ends connected across the body whorl by a thin deposit of callous; almost no indentation in the upper palatal wall. Aperture semicircular and with six teeth. Two on the parietal wall, both of which are lamellar in shape, and the angle tooth is the smaller of the two. One columellar in the center of that wall of the aperture. This tooth is bifid, that portion toward the apex of the shell being the larger. One basal tooth, small and nodule-like. Two palatals, both of which are lamellar in shape, the lower one of which is the larger. Variation in a large series of this species is slight.

Measurements.

Alt.	Diam.
1.77	1.04
1.74	1.04
1.63	1.04
1.55	1.04

Type specimens in the U. S. National Museum from the Pleistocene of Phillips county, Kansas.

This and *Vertigo ovata* are the only species found in this part of the country with two teeth on the parietal wall. The latter species, however, is much the larger and more ovate in outline. The size of *martini* is about the same as that of *gouldi* from the same deposits, but that species is more cylindrical and the angle tooth is never developed. The size is somewhat less than that of *Vertigo tridentata*, a recent shell of eastern Kansas in which the basal tooth is absent.

35. *Succinea grosvenori* Lea.

An abundant fossil, and found living continuously along the bluffs of Miocene exposures. Some of the shells are very large, reaching 19 mm. in altitude and 13 mm. in diameter. These are some of the heaviest *Succineas* in the country. The heavier shells intergrade perfectly with the smaller, lighter ones, so it is supposed that the larger ones are only older individuals.

36. *Succinea avara* Say.

Very common in all the beds. The shells are normal and do not live nearer than central Colorado or eastern Kansas at the present time.

37. *Succinea sillimani* Bland.

Rare; only about a dozen specimens found.

38. *Carychium exile canadense* Clapp.

Naut. XIX, p. 138; pl. VII, figs. 1, 2, 6, 7; Apr., 1906.

This form is rare in the deposits. Only a few were found, and they agree with the form above except in being more slender and the internal basal ridge is more strongly developed than the figures show. The striæ are not numerous, but are high and coarse and resemble ribs on the body whorl, but they are not uniform and regular.